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(54) **A LED AND LED LAMP**

(57) This invention relates to a light emitting diode (LED) and a LED lamp consisted of LEDs. The LED comprises at least one LED chip. The LED is mounted on a high heat conductivity base and is connected to an applied power supply through a circuit board. The LED chip also has a transparent medium layer on it. The base top surface acts as a light reflective surface, or a light reflective surface is provided around the base, the LED comprises a screw extended downwards from the base

bottom or a screw hole in the base bottom to connect the LED to a heat sink mechanically. The LED is electrically connected to a driving circuit through its outgoing wires. The driving circuit is in turn electrically connected to an electrical connector through its housing. A LED lamp can be fabricated after the LED is enclosed in a transparent bulb housing. The LED has high efficiency, high power and long lifetime and can be used to fabricate LED traffic lamps, LED plane light sources, etc.

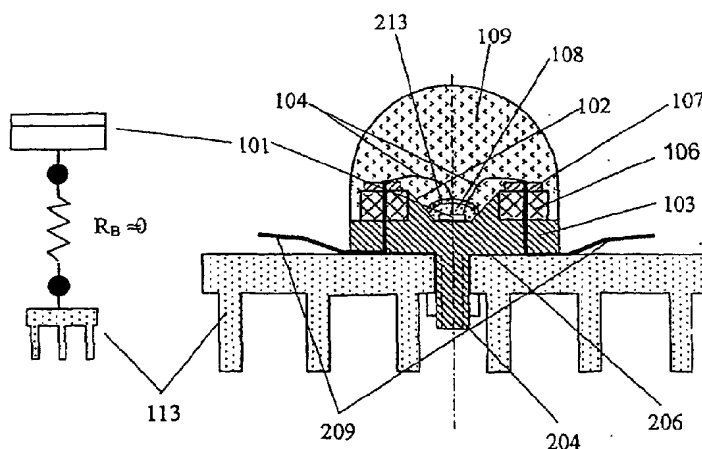


Fig 2

**Description****Technical Field**

5 [0001] This invention relates to a light emitting diode (LED) and LED lamp, more specifically to a high power, high efficiency and long lifetime LED and LED lamp devices, such as illumination lamp, traffic lamp and information display device etc.

**Background of the invention**

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[0002] LED has been widely used in signal indication, large screen display, and has advantages of long lifetime, good colour, sturdiness, etc. At the present, only low power LED can be fabricated. The power of typical LED is only  $20\text{mA} \times 4\text{V} = 80\text{mW}$  because the increase of the operating current will cause the rapid increase of the LED chip temperature, and in turn the luminous efficiency will decrease nearly linearly with the chip temperature increase. The efficient escape of the large quantity of heat created by LED has become the key to fabricating LED and LED lamp.

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[0003] For prior typical high power LED, which is under developing as shown in Fig. 1, a LED chip 101 is bound on the light reflecting surface 102 of a metal base 103. The latter is bound to a circuit board 106 by epoxy layer 111. The leads 104 and legs 105 of the LED chip 101 are connected to the electrical conduction layer 107 of the circuit board 106. An optical glue layer 108 and lens 109, 110 are provided on the chip 101. Element 110 is a fixing one.

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[0004] It can be seen that LED chip is connected to a heat sink 113 via the metal base 103 (heat resistance  $R_B$ ), epoxy layer 111 (heat resistance  $R_E$ ), circuit board (heat resistance  $R_P$ ) and binding glue 112 (heat resistance  $R_A$ ). The total resistance  $\Sigma R = R_B + R_E + R_P + R_A$  is great, so the chip temperature increases easily, and the luminous efficiency decreases rapidly. At the same time, the chip mounting metal base is glued to the circuit board 106. The epoxy glue is easy to be split after a long operating cycle under the condition of being cold and hot, expanded and contracted repeatedly due to the different heat expansion coefficient and different temperature increase speed between the circuit board and the metal base. Glue split increases  $R_E$ , and results in LED damage by overheating. In summary, high power, high luminous efficiency and long lifetime LED for lighting is difficult for manufacturing by the prior art.

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**Brief summary of the invention**

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[0005] The object of the invention is to overcome the disadvantages of great heat resistance between the LED and the heat sink, the rapid increase of the chip temperature and thereby the rapid decrease of the LED luminous efficiency; to overcome the disadvantages of glue split between the metal base and the circuit board after a long operating time due to the different heat expansion coefficient between them, the great heat resistance increase between LED and the heat sink and thereby the LED damage by overheating; so that a high power, high efficiency and long lifetime LED and LED lamp can be provided.

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[0006] The object of the invention is achieved in such a way that the LED of the invention comprises at least one LED chip mounted on a high heat conductive base. The LED chip is electrically connected to an applied power supply and has a transparent medium layer on it. The base top surface acts as a light reflecting surface or a light reflecting surface is provided around the base, wherein, a circuit board is provided on or around the base.

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[0007] The LED also includes at least one screw or a screw hole to mechanically connect the LED to a heat sink.

[0008] A light reflector is provided at the front of the LED chip. The transparent medium includes optical glue and lens.

[0009] The LED chips emit same colour light or different colour light and are connected together in a serial or/and parallel form.

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[0010] The base is a metal base, ultra high heat conductivity tubes or an assembly of a metal base and ultra high heat conductivity tubes provided on the bottom of the metal base.

[0011] The light reflector has a light reflecting surface, which make an angle in- a range between  $10^\circ$  and  $70^\circ$  to the LED axis.

[0012] Light converting material is provided within the optical glue layer or between the optical glue layer and lens.

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[0013] A LED lamp consisted of the above LED is characterized in that at least one above LED is mechanically connected to a heat sink, and the leads of the LED are electrically connected to an electrical connector through its housing, and the LED is enclosed in a transparent bulb housing.

[0014] The electrical connector is a double leg bayonet lamp head, multi-leg bayonet lamp head or screw lamp head.

[0015] The transparent bulb housing is transparent, coloured, or light scattering bulb housing made of glass or plastic.

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[0016] A light converting material layer is provided on the inner surface of the transparent bulb housing.

[0017] The heat sink has heat dispersing flanges.

[0018] The heat flange comprises a single spiral flange or a plurality of spiral flanges. The inner surface of the heat sink is light reflective.

[0019] The inner surface of the heat sink is cylindrical or parabolic.

[0020] A traffic lamp consisted of the above LED is characterized in that the LED has a divergence angle between 3° and 60° , and is mounted on a heat sink near the focus of the parabolic reflector of the traffic lamp. The light from some of the LEDs is emitted outside of the window of the original traffic lamp and the remaining light is radiated outside after reflecting form the parabolic light reflector of the original traffic lamp to obtain the light radiation with desired focus and uniform distribution.

[0021] A LED plane light source consisted of the above LEDS is characterized in that at least one LED is mounted on a heat sink consisted of a flat heat dispersing plate. The sink is located on the backside of and around the light guiding plate of the back illuminance source for plane light source or liquid crystal display. Light reflectors are disposed on both sides of or around the LED.

[0022] The LED comprises a plurality of LEDs emitting the same colour light or different colour light.

[0023] The advantages of the invention are as following:

(1) The heat sink is connected directly and closely to the base so that the heat resistance between the chip and the heat sink is nearly zero, and leading to the efficient escape of the heat created by the LED. In addition, the metal base is connected to the heat sink by metal screws and therefore the heat connection between them is reliable and unchangeable after a long time operation. Therefore, a high power, high efficiency and long lifetime LED can be fabricated;

(2) The circuit board is disposed on or around the metal base to facilitate the connection between chips and to facilitate dense installation, without the increase of the heat resistance between the chip and the sink.

(3) LED lamps and LED plane light source can be fabricated.

[0024] In summary, the LED of the invention may overcome the problems of the large heat resistance and glue split of the prior LED, and also may have a much smaller volume than the prior LED and thereby is adapted to dense installation.

#### Brief description of the several views of the drawings

[0025]

Figure 1 is a structural schematic view of the prior LED;

Figure 2 is a structural schematic view of an embodiment of a LED according to the invention;

Figure 3 is a structural schematic view of an embodiment of the lower leads of the LED according to the invention;

Figure 4 is a structural schematic view of an embodiment of a LED according to the invention, wherein a light reflector is provided;

Figure 5 is a structural schematic view of another embodiment of a LED according to the invention, wherein, a light reflector is provided;

Figure 6 is a structural schematic view of a LED lamp according to the invention;

Figure 7A is a structural schematic view of a LED lamp according to the invention, wherein, a parabolic heat sink is provided;

Figure 7B is a structural schematic view of another embodiment of a LED lamp according to the invention, wherein, a cylindrical heat sink is provided;

Figure 8 is a structural schematic view of an embodiment of a LED lamp according to the invention, wherein, ultra-high heat conductivity tubes are provided;

Figure 9 is a structural schematic view of an embodiment of a LED lamp according to the invention, wherein, a bulb heat sink is provided;

Figure 10 is a structural schematic view of a traffic lamp consisted of the LED according to the invention;

Figure 11 is a structural schematic view of a plane light source consisted of LEDs according to the invention.

#### Denotation of the drawings

[0026]

LED chip	101	metal base	103
Circuit board	106	glue	112
Leads	104	LED leg	105
Optical glue	108	lens	109

(continued)

Screw	204	heat conduction glue	206
Light conversion material	213	insulating layer	303
Color mixture	409	screw hole	408
Connection lead between chips	410	heat conduction layer	407
The housing of the driving circuit	604	input lead	607
Light conversion material layer	609	transparent bulb housing	608
Ultra-high heat conductivity tube	801	heat absorbing end	803
Transparent window	1008	heat dispersing plate	1103
Optical plate	1107	second circuit board	1106
Reflective surface	102	heat sink	113
Conductive layer	107	fixing device	110
Outgoing line	209	light reflector	406
Heat dispersing flange	404	driving circuit	603
Electrical connector	605	LED	701
Second transparent bulb housing	908	light guiding plate	1104

## Detailed description of the embodiments

### Embodiment 1

**[0027]** A LED of the invention, as shown in Fig. 2, is fabricated, in which at least one LED chip 101, such as yellow colour light emitting LED, is mounted on the reflective surface of a metal base 103. When more than two LED chips 101 are used, the LED chips may emit the same colour light or different colour light. The metal base 103 is thermodynamically and mechanically connected to a heat sink 113 closely through at least one screw 204. Heat conduction glue 206 is provided between metal base 103 and the heat sink 113 to obtain better heat connection. A circuit board 106 is disposed on the metal base 103 and has an electrical conductive layer 107, to which outgoing leads 209 are connected. The outgoing leads 209 are insulated from the metal base and the heat sink 113, and are connected to an applied power supply. The LED chip 101 is connected to the circuit board 106 through leads 104. Optical glue 108 and lens 109 are provided on the LED chip 101, light conversion material 213 is provided between optical glue 108 and lens 109 to converse the light emitted from the LED chip 101 into different colour light. The metal base is made of very low heat resistively copper, so, the heat created by the LED chip 101 is easy to escape, and the LED chip may operate in a high luminous efficiency condition at low temperature.

### Embodiment 2

**[0028]** A LED of the invention is fabricated, in which lower leads are used, as shown in Fig. 3. At least one LED chip 101, for example two LED chips, are mounted on the light reflective surface 102 of the metal base 103. The LED chips emit different colour light. The metal base 103 has at least one screw 204 to thermodynamically and mechanically connect the metal base 103 to the heat sink 113 closely. A circuit board 106 is disposed around the metal base 103 and has an electrical conductive layer 103 on it to connect outgoing leads 209. The outgoing wires extend right down wards though the insulation layer 303 and are connected to an applied power supply. Transparent medium is provided on the LED chip 101 and has a top surface designed to be spherical or ellipsoidal depending on the desired output light distribution. The metal base 103 is made of low heat resistively aluminium or its alloy. The remaining is the same as Embodiment 1.

### Embodiment 3

**[0029]** A LED of the invention, as shown in Fig. 4, is fabricated, in which a light reflector is provided, wherein, a light reflector is added over at least one LED chip 101 so that the light 402 emitted towards the LED sides may be reflected back to the LED chip 101 or the reflecting surface 102, and than emitted forwards. Therefore, the light availability factor is increased. When more than two LED chips are used and radiate different colour light, colour mixture may be provided between the reflector 406 and the LED chip 101 to enhance light colour mixing effect. One electrode of one LED chip 101 is connected to the metal base 103, and then is led outside through at least one of the screw hole 408 and screw 204. The other electrode lead of the LED chip 101 is connected to the outgoing wire 209 through the lead 104. The

outgoing wire 209 extends outside through the insulating layer 303 and then is connected to an applied power supply. A lead 410 is connected between each two adjacent LED chips. The heat sink has heat dispersing flanges. The heat conductive layer 407 is an electrical insulation layer. The remaining is the same as Embodiment 2.

#### Embodiment 4

[0030] A LED of the invention is fabricated, in which a light reflector is provided, as shown in Fig. 5, wherein, a light reflector 406 is added above the LED chip 101 such that the light 503 emitted towards the sides may be reflected forwards to increase light availability. Light conversion material 213 is provided on the surface of the LED chip 101. At least 2 outgoing wires 209 of the circuit board 106 extend outside right downwards through the metal lease 103 and are then connected to an applied power supply. The remaining is the same as Embodiment 3.

#### Embodiment 5

[0031] A LED lamp consisted of the LED of the invention, as shown in Fig. 6, is fabricated, in which at least one LED chip 101 is mounted on the heat sink 113. The outgoing wires 209 of the LED are electrically connected to a driving circuit 603. The driving circuit 603 and its housing are connected to an electrical connector 605 through an input wire 607. The driving circuit 603 converts input voltage into the voltage adapted to the LED operation and to light the LED. A transparent bulb housing 608 made of glass houses the LED, and the inner surface of the transparent bulb housing is coated with a light conversion material layer 609 to convert the light emitted by the LED into a desired colour light.

#### Embodiment 6

[0032] A LED lamp of the invention is fabricated, in which a heat sink is provided, wherein, the LED 701 is mounted in a parabolic heat sink 113 as shown in Fig. 7A, or in a cylindrical heat sink 113, as shown in Fig. 7B. The heat sink has heat dispersing flanges 404 on it and its inner surface is a light reflective surface 702. In Fig. 7A the electrical connector 605 is a two-leg bayonet lamp head and is connected to an applied power supply. In Fig. 7B the electrical connector 605 is a three-leg bayonet lamp head and is connected to an applied power supply. The housing 604 of the driving circuit board 603 houses the driving circuit board 603. The remaining is the same as Embodiment 1.

#### Embodiment 7

[0033] A LED lamp of the invention is fabricated, in which, ultra-high heat conductivity tubes are provided as shown in Fig. 8, wherein, at least one LED 701 is mounted at the absorbing end 803 of a ultra-light heat conductive tube (called heat tube for short) 801, and the other end of the heat tube 801 is connected to a heat sink 113. Since the heat tube has heat conductivity 1500 times greater than copper has, its heat resistance is nearly zero, and therefore the heat created by the LED chip 101 can be transferred to the heat sink through the heat tube 801 rapidly and then escapes. The remaining is the same as Embodiment 5.

#### Embodiment 8

[0034] A LED lamp of the invention is fabricated, in which an ultra-high heat conductivity tube and a bulb heat sink are provided, as shown in Fig. 9. In the LED lamp at least one LED chip 101 or LED 701 is mounted on a metal base 103. The metal base is made of a low resistively alloy and is mounded at the top end of the ultra-high heat conductivity tube 801. The other end of the heat tube 801 is connected to a heat sink. The heat sink has a plurality of spiral heat dispersing flanges of a bulb contour to accelerate air flow between flanges and enhance the heat dispersing effect of the heat sink. A reflective surface 102 is provided on the heat sink 113 and around the metal base 103. A transparent bulb housing 608 is mounted over the LED and has a light converting material layer on its inner surface. A second transparent bulb housing 908 is provided, as shown in Fig. 9. The remaining is the same as Embodiment 5.

#### Embodiment 9

[0035] A traffic lamp consisted of LEDs of the invention, as shown in Fig. 10, is fabricated, in which at least one LED 701 is mounted on a good heat conductive metal base 103. The metal base 103 is connected to a heat dispersing device 113. The LED has a divergence angle of from 3°-60° and is mounted on a heat sink 113 near the focus of the parabolic light reflector of an original traffic lamp. The light emitted from some of the LEDs is emitted outside through the transparent window 1008 of the original traffic lamp, and the remaining light is emitted outside after reflecting from the parabolic light reflector 406. The LED traffic lamp may replace the prior tungsten traffic lamp directly. The remaining

is the same as Embodiment 5.

# Embodiment 10

[0036] A plane light source consisted of LEDs of the invention, as shown in Fig. 1. is fabricated, in which a LED 701 is mounted on a heat sink 113 having a flat heat plate 1103 of a large area. The heat dispersing plate 1103 is located on the back side of and around the light guiding plate 1104 of the plane light source. A second circuit board is provided on the back and outside of the heat sink 113 to connect the LEDs 701, and connect to an applied power supply. The heat dispersing plate 1103 may also have heat dispersing flanges 404. A light reflector 406 is located on the two sides of or around the LED 701 to efficiently couple the light emitted from the LED 701 into the light guiding plate 1104. An optical plate 1107 is provided as a liquid display plate, optical enhancement plate, scattering plate or a transparent plate with pattern and/or text, etc. The at least one LED 701 emits the same colour light or different colour light. Plane light source and back illumination light source of white light of different colour temperature, colour light or colour changeable light can be achieved through control of the brilliance of respective LED emitting different colour light.

## Claims

1. A LED, comprising:

at least one LED chip mounted on a base of high heat conductivity, the LED chip is electrically connected to an applied power supply through a circuit board and has transparent medium layer on it, and the base top surface acts as a light reflective surface or a light reflective surface is provided around the base, wherein, circuit boards are provided on or around the base.

2. The LED according to claim 1, wherein, at least one screw or screw hole is provided on or in the base bottom to mechanically connect the base to a heat sink.

3. The LED according to claim 1, further comprising a light reflector at front of the LED chip.

4. The LED according to claim 1, wherein, the transparent medium is optical glue and a lens.

5. The LED according to claim 1, wherein, the LED chips are a plurality of LED chips emitting the same colour light or different colour light, the chips are connected to each other in a serial or/and parallel form.

6. The LED according to claim 1, wherein, the base is a metal base, an ultra-high heat conductivity tube or an assembly of a metal base and ultra-high heat conductivity tube under the metal base.

7. The LED according to claim 3, wherein, the angle between the light reflecting surface and the LED axis is an angle from 10° to 70°.

8. The LED according to claim 4, further comprising light converting material in the optical glue or between the optical glue and the lens.

9. A LED lamp consisted of the LEDs of claim 1, comprising:

at least one LED, mechanically connected to the heat sink through screws or screw holes on or in the base bottom of the LED;  
a driving circuit, to which outgoing leads of the LEDs are connected; and  
transparent bulb housing mounted over the LED.

10. The LED lamp according to claim 9, wherein, the electrical connector is a double-leg bayonet lamp head, multi-leg bayonet lamp head or a screw lamp head.

11. The LED lamp according to claim 9, wherein, the transparent housing is a transparent, coloured or scattering bulb housing made of glass or plastic.

12. The LED lamp according to claim 9, wherein, a light converting material layer is coated on the inner surface of the

bulb housing.

13. The LED lamp according to claim 9, wherein, the heat sink has heat dispersing flanges on it.

5 14. The LED lamp of claim 13, wherein, the heat sink has a single heat dispersing spiral flange or a plurality of circumferential heat dispersing flanges.

15. The LED lamp according to claim 13, wherein, the inner surface of the heat sink is a light reflection surface.

10 16. The LED lamp according to claim 15, wherein, the inner surface is cylindrical or parabolic.

17. A LED traffic lamp, wherein, at least one LED is mounted on the heat sink near the focus of the parabolic light reflector of a traffic lamp, the divergence angle of the LED is an angle in a range between  $3^{\circ}$  and  $60^{\circ}$ , the light emitted by some of the LEDs is emitted outside through the transparent window of the traffic lamp, the remaining light is emitted outside after reflection from the parabolic reflector of the traffic lamp to obtain a desired focus.

18. A LED plane light source, wherein, at least one LED is mounded on a heat sink having a flat heat dispersing plate, the radiator sink is located on the back side of and around the light guiding plate of a back illumination light source for a plane light source or liquid crystal display, light reflectors are disposed on the two sides of or around the LED.

20 19. The LED plane light source according to claim 18, wherein, the LEDs emit the same colour light or different colour light.

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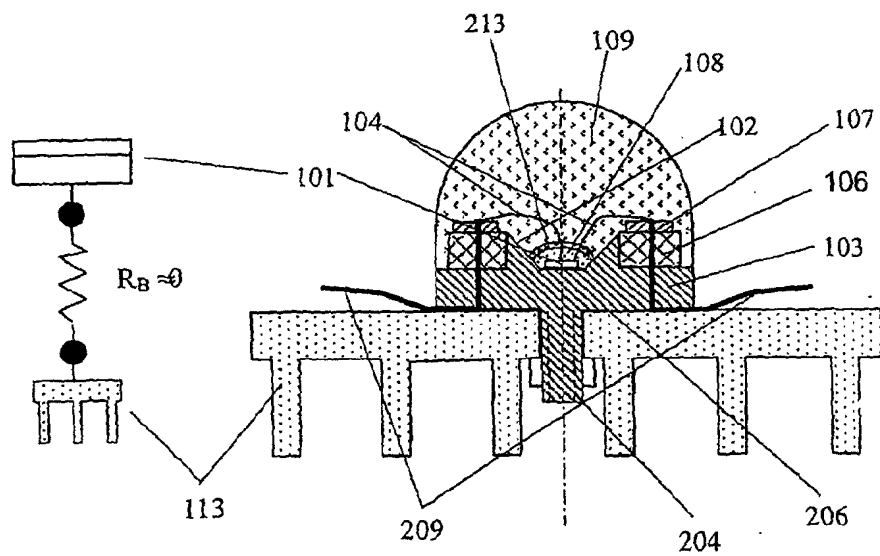
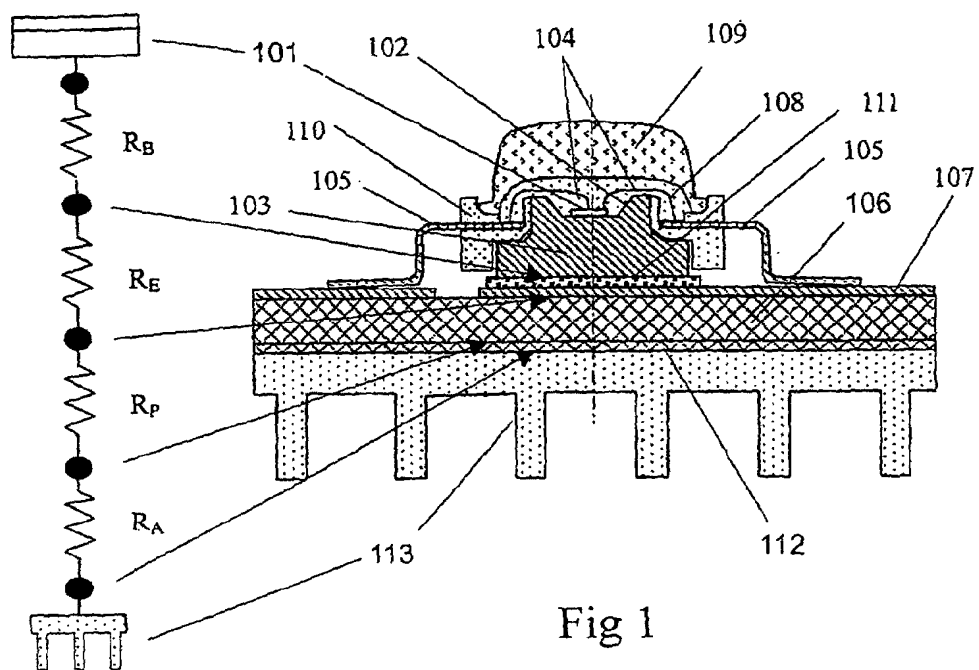
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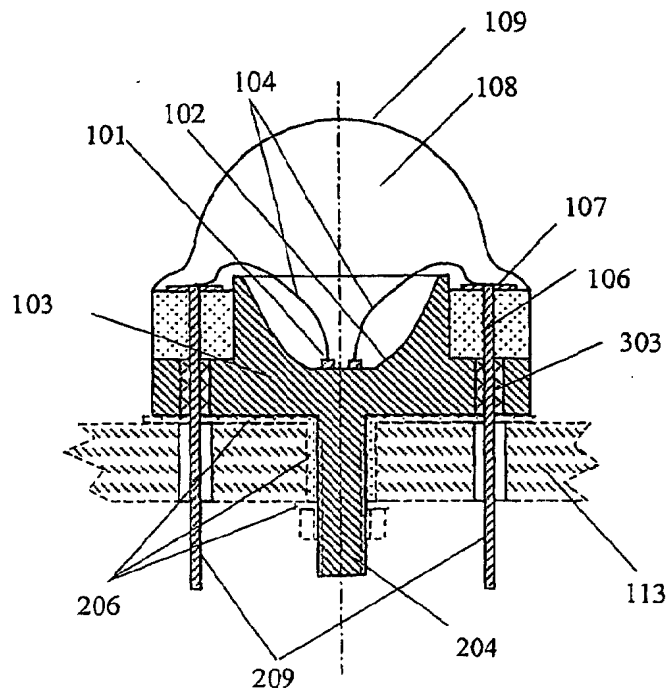


Fig 3

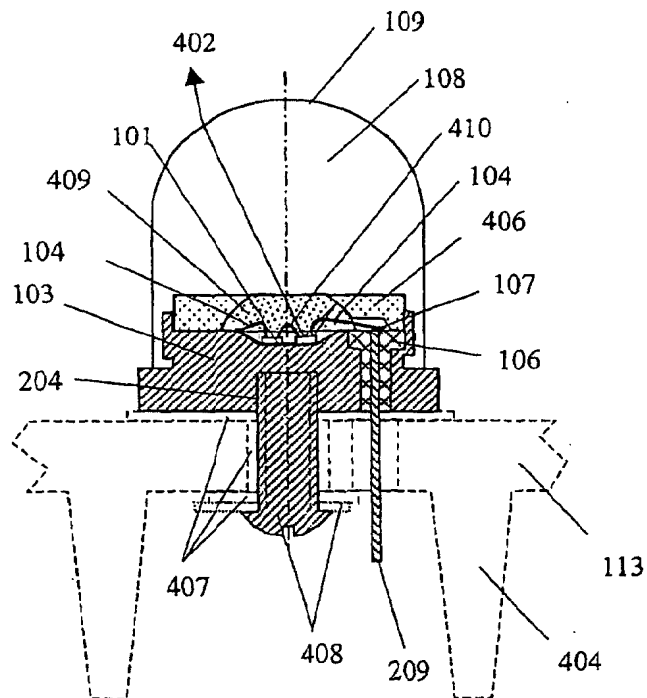


Fig 4

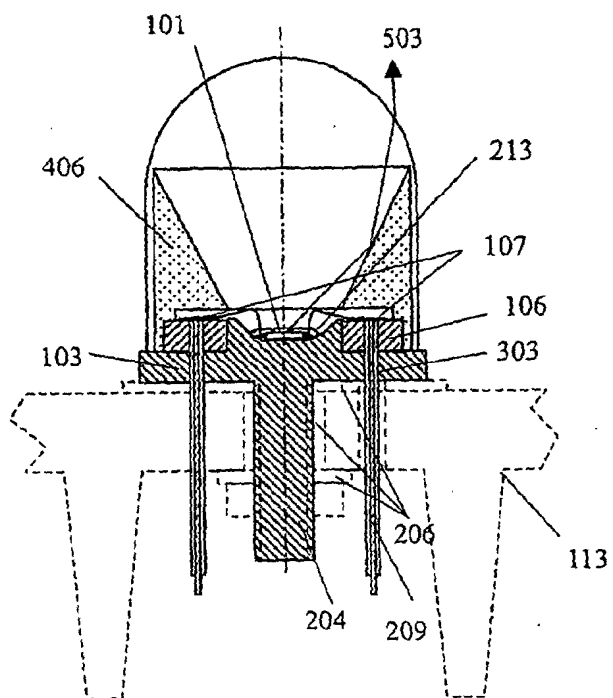


Fig 5

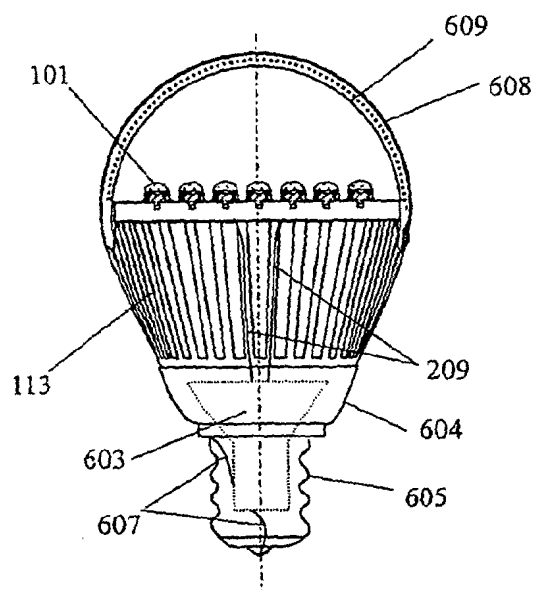


Fig 6

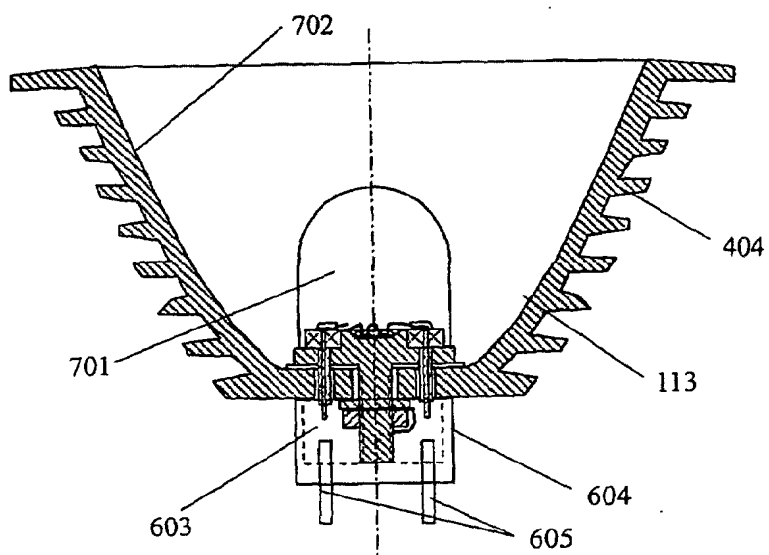


Fig 7A

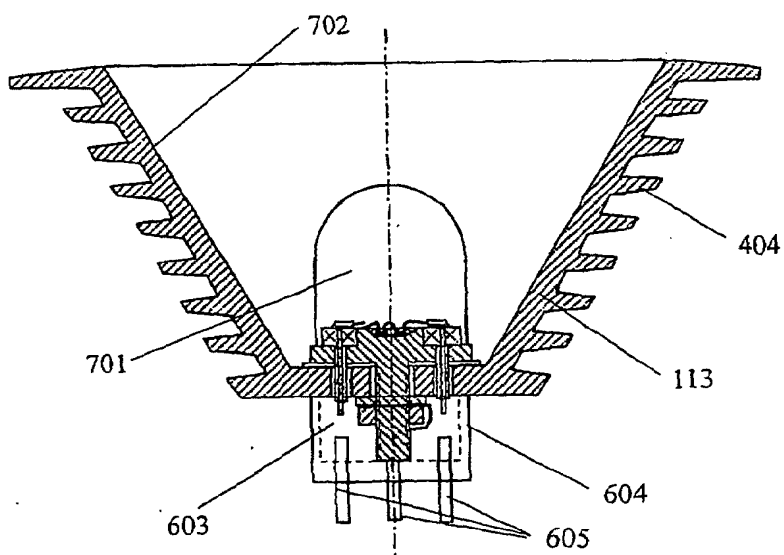


Fig 7B

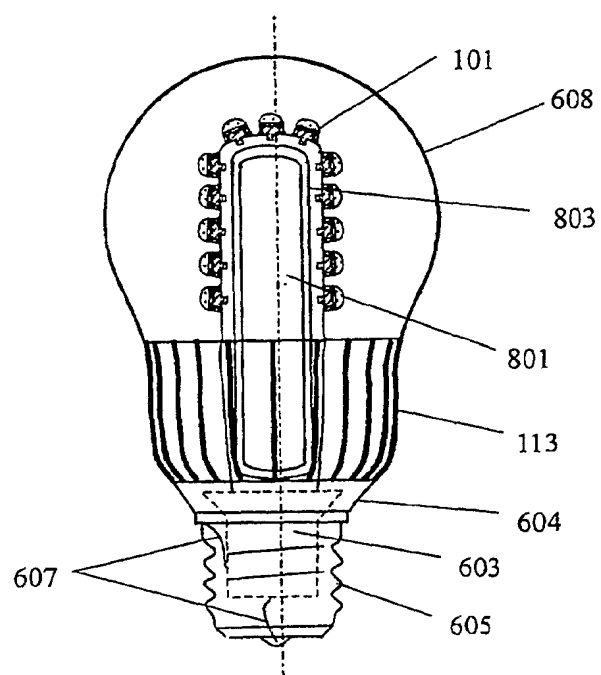


Fig 8

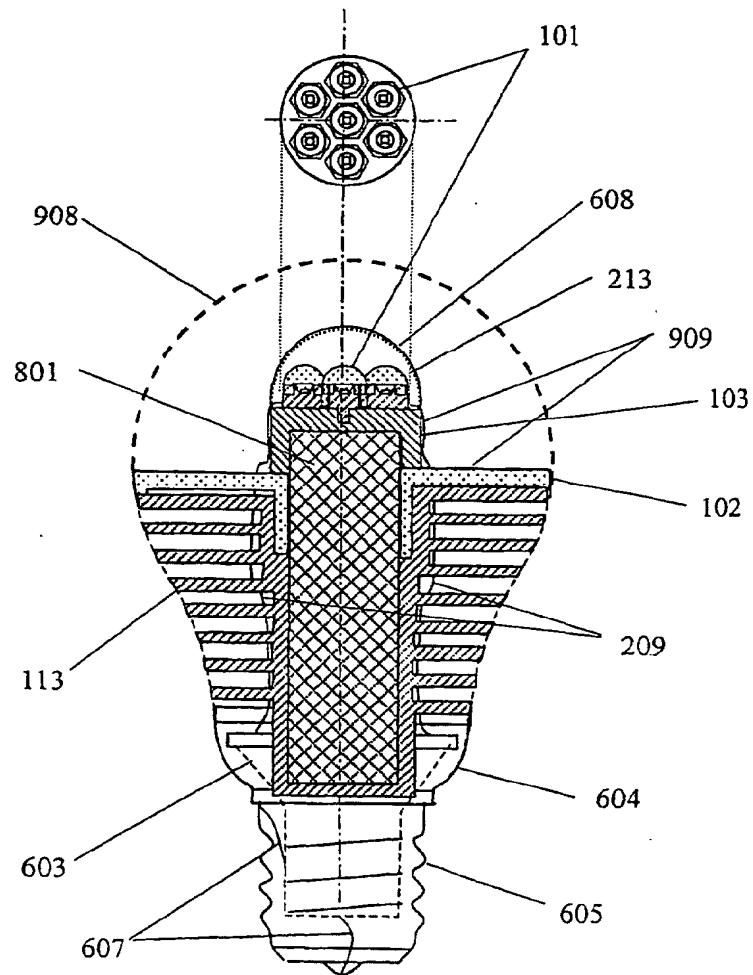


Fig 9

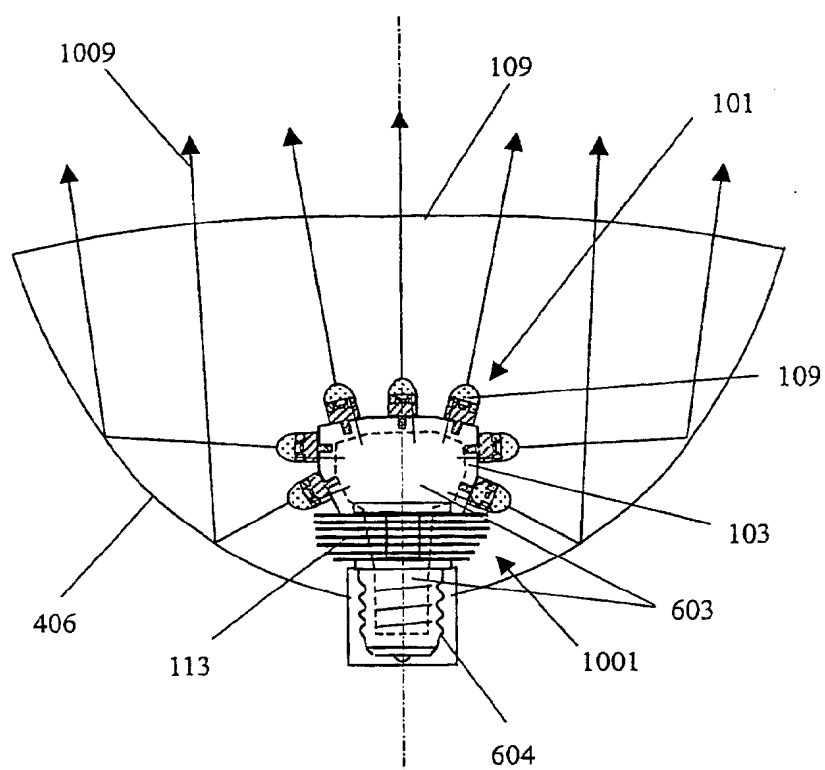


Fig 10

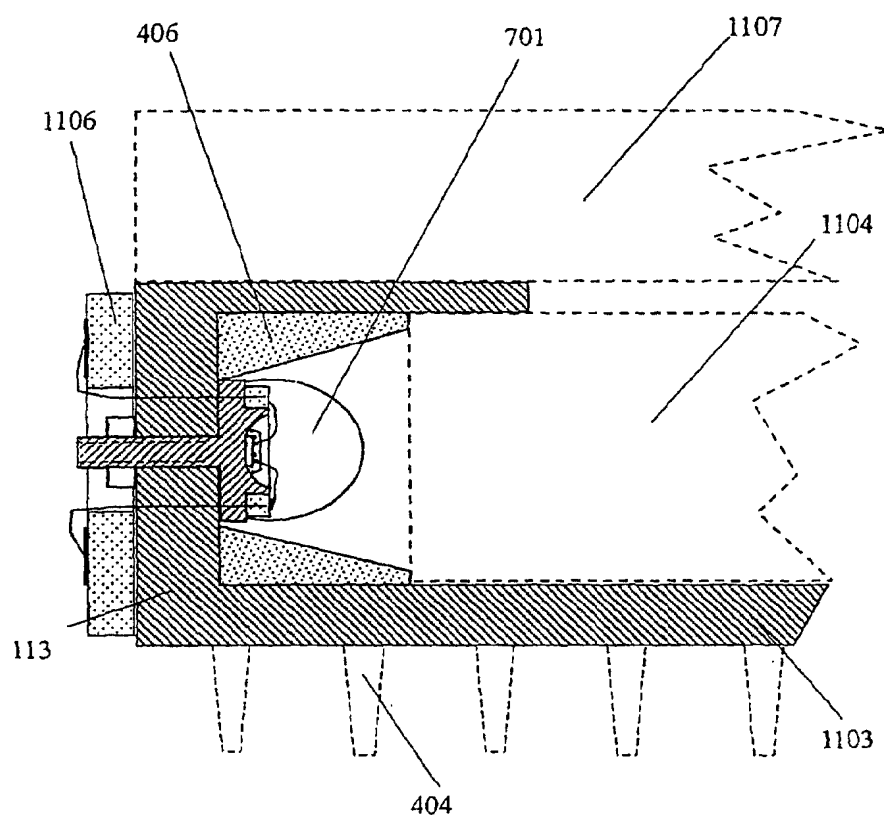


Fig 11

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/CN02/00930

## A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl<sup>7</sup> H01L 33/00, F21S 2/00, G08G 1/095

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl<sup>7</sup> H01L 33/00, F21S 2/00, G08G 1/095

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Chinese Documents(1985-)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT,EPODOC,WPI,PAJ: LED, chip,base,light reflecting plane,radiactor,traffic sign,surface light source

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	CN2386535Y (YIGUANG ELECTRONICS CO LTD) 05.July 2000 (05.07.00) all document	1-8
A	CN2256561Y (SHANGHAI NORTH-SOUTH MECHANICAL&ELECTRICAL ENGINEERING LTD) 18.June 1997 (18.06.97) all document	18-19
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A	CN2444117Y (SHENZHEN SAIWEI INDUSTRIAL LTD) 22.August 2001(22.08.01) all document	9-16

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  
20.February 2003(20.02.03)

Date of mailing of the international search report

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6 Xitucheng Rd., Jimen Bridge, Haidian District,  
100088 Beijing, China  
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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/CN02/00930

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Form PCT/ISA /210 (continuation of Second sheet (2)) (July 1998)

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Information on patent family members

International application No.  
PCT/CN02/00930

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